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CITATION:

Matubayashi, Kozo ...[et al]. Non-Caucasian and High Altitude. ヒマラヤ学誌 2011, 12: 3-6

ISSUE DATE:

2011-05-01

URL:

https://doi.org/10.14989/HSM.12.3

ヒマラヤ学誌　*No.12, 3-6, 2011*

Editorial

Non-Caucasian and High Altitude

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High Altitude Climbing by Caucasians and Non-Caucasians

High-altitude climbing was popularized primarily by Caucasian travelers. Caucasian missionaries who traveled to the Andes and Himalayas from the 16th to 19th centuries possessed extensive knowledge about high-altitude disorders. In contrast, high-altitude climbing was uncommon among non-Caucasians until after the Second World War. Table 1 groups climbers who reached the top of Mt. Everest after 1953 by country, demonstrating how modern Western culture has influenced mountain climbing in the Himalayas. Everest summiteers are 33% Caucasian; among non-Caucasians, Japanese, Koreans, Chinese, and Indians together comprise 18%, and Nepalese Sherpa account for 39% (Table 2). Table 3 shows the mortality rates of Everest summiteers from 1970 to 2004. The data suggest that while high-altitude adaptation of the Nepalese Sherpa was relatively high, the ability to adapt to extremely high altitudes does not differ greatly between Caucasians and non-Caucasians living at sea-level.

The term "non-Caucasians" includes people of Asian and African descent, some of whom reside in lowlands and some of whom reside in highlands. Representative highland residents include the Andean, Tibetan (including the Sherpa), and Ethiopian populations, all of whom are non-Caucasians. Nepalese Sherpa and Tibetans who make a living as mountaineering guides possess physiologic traits that are advantageous for high-altitude climbing. However, the aptitude for high-altitude climbing among the Andean or Ethiopian highland populations, who do not have a climbing culture, is unclear. Protection from the effects of extreme high altitudes does not appear to differ between Caucasians and non-Caucasians living at lowland regions.

Non-Caucasian Highlanders and Physiologic Adaptation to Highland Hypoxia

The Andean, Tibetan, and Ethiopian people living at high-altitudes are all non-Caucasian populations; few Caucasians live in such environments. The highlanders are thought to have acquired genetic adaptations to hypoxic conditions, but the precise form of adaptation to hypoxia appears to differ among these groups. According to a report by Beall CM,[1)] a comparison of oxygen saturation and blood hemoglobin between Andean, Tibetan, and Ethiopian populations revealed that oxygen saturation of people living in the Andes and Tibet is lower than that of lowlanders; however, Andeans exhibited a large elevation in hemoglobin concentration whereas Tibetans exhibited only a moderate increase. In contrast, neither decreased oxygen saturation nor increased hemoglobin concentration has been observed in Ethiopian highlanders (Table 4). These results suggest that the primary form of adaptation to a hypoxic environment in Andean highlanders appears to be elevated hemoglobin, the blood component that carries oxygen to all parts of the body. This phenomenon of elevated hemoglobin is also observed when lowland residents travel to the highlands. Thus Andeans, whose ancestors began living at high altitudes only about 10,000 years ago, appear to have perfected the hypoxic adaptation strategy available to individuals currently living at low altitudes. In contrast, widening of blood vessels to increase blood flow appears to be an important part of the hypoxic adaptation of Tibetans, who are considered

Table1　Number of Everest Sumitters（1953 － 2003）

	N. of Sumitters	Rate
USA	235	0.12
UK	68	0.04
France	58	0.03
Spain	54	0.03
Russia	76	0.04
Japan	106	0.06
Korea	48	0.03
China	56	0.03
India	66	0.03
Nepelese Sherpa	730	0.39
Others	399	0.21
Sum	1896	

Table2　Number of Everest Sumitters（1953 － 2003）

Caucasian	491	0.33
Non-Caucasion, non-Sherpas	276	0.18
Nepalese Sherpas	730	0.49
	1497	

Table3　Death Rate of Everest Sumitters（1970 － 2004）

	N. of Sumitters	N.of Death	Death Rate
Total (1970-2004)	2225	167	7.51
Japanese (1970-2004)	118	6	5.08

Table 4　Difference in SpO_2 and Hemoglobin Concenration among Lowlanders and Highlanders (Source: Reference 1)

	Altitude (m)	SpO_2 (%)	Hemoglobin （g/dl）
Lowlanders	0	97	15.3
Andean Highlanders	4000	92	19.1
Tibetan Highlanders	4000	89	15.8
Ethiopian Highlanders	3500	95	15.6

to have reached the highlands about 20,000 years ago. Although Tibetans and Chinese Hans both reside in China's Qinghai Province, a comparison of hemoglobin concentrations of these populations living at the same altitude has demonstrated that the Chinese Hans have significantly higher hemoglobin concentrations than Tibetans; in addition, disorders due to polycythemia are more common in Chinese Hans.[2-5] This finding may be explained, at least in part, to Tibetans' vasodilation and increased blood flow—an adaptation strategy that is long-term on the evolutionary time-scale—which reduced the need to boost hemoglobin levels. Research in Ethiopia has been insufficient; thus it is unclear how Ethiopians, who are considered to have had the longest history of living at high altitudes (i.e., more than 50,000 years), have adapted to hypoxia in evolutionary terms. However, no studies have so far reported increased hemoglobin or blood flow in highland Ethiopians. Considerable archeological evidence indicates that *Homo sapiens* originated from that region of Africa, and it is likely that humans reached the highlands of Ethiopia much earlier than they reached the Andes or Tibet. For that reason, residents of Ethiopia may have acquired a physiologic adaptation that differs from the relatively new adaptations of increased hemoglobin or vasodilation with increased blood flow.

Non-Caucasian Highlanders and Cultural Adaptation to Highlands

In contrast to genetic adaptations, cultural adaptations to the extreme environment can minimize the physiologic changes required to thrive in highland regions. In addition, highland residents of each continent identified resources—in particular, wild animals and plants with the potential to be domesticated and cultivated—that have allowed them to thrive and ensured their long-term survival. Highland residents of the Andes have cultivated hardy food plants such as potatoes and domesticated the llama and alpaca; residents of Tibet have cultivated barley and domesticated the yak. Ethiopians have cultivated teff and ensete, which are unique to that region. Furthermore, highland residents have developed distinct religions, as in the worship of many Andean gods, Tibetan Buddhism, and the Ethiopian Orthodox Church.

Cultural adaptation also brings about the diseases of civilization. Culturally unique ways of thinking, religious ceremonies, and taboos strongly influence the use of technology, resource exploitation, population growth and control, as well as health and survival. Each civilization and society gives rise to unique diseases, and diseases in turn can alter a civilization or society. In Europe, leprosy (13th century), plague (14th century), syphilis (16th century), smallpox and typhoid fever (17th and 18th century), cholera and tuberculosis (19th century), and influenza (20th century) are recognized as virulent diseases unique to each civilization and society.[6] In more recent times, Kuru in Papua New Guinea, leprosy in Southeast Asia, AIDS in Africa, and cardiovascular disease and cancer in Western nations—although influenced by human biological changes—are diseases that are intimately related to the values of each age, civilization, and society. Infectious diseases such as tuberculosis and syphilis, and even acute infectious diseases such as cholera and typhoid fever, do not occur merely because the pathogen is present. The disease can develop only when conditions allow the pathogen to spread and multiply. These conditions are almost always created by society.

With the exception of the American continent in the 16th century, life in sparsely populated mountainous areas, although difficult, was probably without major epidemics. Residents were likely to be generally healthy and lived fulfilling spiritual lives. However, the influence of modern globalism, with its focus on industrialism, market economies, and the information revolution, is spreading to mountainous areas. Globalism inevitably transforms the natural environment and changes man's physical and spiritual way of being. A particularly important "glocal" issue may be to understand how the hypoxic adaptation mechanisms that highland populations have acquired over thousands of years relate to recent lifestyle-related diseases.

The volume, Himalayan Studies Monograph No. 12, provides a wealth of information on high-altitude

adaptation, diseases, and aging in non-Caucasian highlanders, which was revealed by a project entitled "Human Life, Aging, and Diseases in High-Altitude Environments: Physio-medical, Ecological and Cultural Adaptation in "Highland Civilizations" (Leader: Kiyohito Okumiya).

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